

10/581734

IAP20 Rec'd PCT/PTO 06 JUN 2006

GKN Driveline International GmbH  
Hauptstrasse 130  
53797 Lohmar

18<sup>th</sup> December 2003  
Ne/gro (20030596)  
Q03094W000

**Differential carrier with an inner plate package**

Claims

1. A differential drive with a rotatably arranged differential carrier (11) in which a multi-plate coupling (23) is arranged so as to be effective between the differential carrier (11) and a sideshaft gear (29),

characterised in

that the differential carrier (11) comprises a dish-shaped carrier part (12) in which there are received sideshaft gears (28, 29) and differential gears (26, 27) and that the differential carrier comprises a dish-shaped cover (14) which receives the plates of the multi-plate coupling (23).

2. A differential according to claim 1,

characterised in

that, in the sense of rotation, the outer plates of the multi-plate coupling (23) are form-fittingly held in the cover (14) and that, in the sense of rotation, the inner plates of the multi-plate coupling (23) are form-fittingly held on a hub (30) connected to a sideshaft gear (29).

3. A differential according to any one of claims 1 or 2,

characterised in

that on the outside of the cover (14), there is arranged a sleeve (51) which axially supports an actuator (31) for the multi-plate coupling (23).

4. A differential according to claim 3,

characterised in

that the actuator (31) is radially supported on the sleeve (51).

5. A differential according to any one of claims 1 to 4,

characterised in

that the cover, on its circumference, comprises apertures (22).

6. A differential according to claim 5,

characterised in

that the cover comprises blades (24) which are associated with the apertures (22) and which have a centripetal effect on a surrounding medium.

7. A differential according to any one of claims 1 to 6,

characterised in

that the cover comprises axial bores (54) in which there are positioned axially movable journals (47) for transmitting an axial movement from the actuator (31) to the multi-plate coupling (23).

GKN Driveline International GmbH  
Hauptstrasse 130  
53797 Lohmar

18<sup>th</sup> December 2003  
Ne/gro (20030596)  
Q03094W000

**Differential carrier with an inner plate package**

**Description**

The invention relates to a differential drive with a rotatably arranged differential carrier in which a multi-plate coupling is inserted so as to be effective between the differential carrier and a sideshaft gear. Such multi-plate couplings are used in lockable differential drives wherein, by actuating the multi-plate coupling, there is built up a locking moment between the differential carrier and one of the sideshaft gears and thus, also indirectly, between the sideshaft gears, so that a torque introduced into the differential carrier is effectively built up at both sideshaft gears even in those cases where there is no counter moment at one of the sideshaft gears. Differential drives of said type are used in motor vehicles in the form of axle differentials between the driving wheels of a driving axle or as central differentials between two driving axles. In the case of prior art differential carriers, the space needed for the multi-plate coupling requires a very deep carrier part which is difficult to machine.

It is therefore the object of the present invention to propose an improved differential drive whose differential carrier does not feature the existing disadvantages and which has advantageous effects.

The objective is achieved in that the differential carrier comprises a dish-shaped carrier part in which there are received sideshaft gears and differential gears and that the differential carrier comprises a dish-shaped cover attached thereto which receives the plates of the multi-plate coupling. This solution achieves the required axial depth in the cover of the differential carrier, which depth is needed for the plate package of the multi-plate coupling, so that the carrier part is axially shorter and thus stiffer, while, at the same time, the cover, due to its dish shape, can take over additional functions. The dish shape of the carrier part and cover means that each is provided with a base and a casing and, for inter-connection purposes, flange portions can be provided at the aperture end. The flange portions at the two carrier parts required for fixing a driving ring gear are now positioned more centrally with reference to the longitudinal extension of the parts, so that, with reference to the bearing means of the differential carrier, the introduction of power is more advantageous.

According to a preferred embodiment of the invention, it is proposed that, in the sense of rotation, the outer plates of the multi-plate coupling are form-fittingly held in the cover and that, in the sense of rotation, the inner plates of the multi-plate coupling are form-fittingly held on a hub connected to a sideshaft gear. This means that there is no need for any intermediate carriers or the like for the multi-plate coupling and that it is possible to pre-assemble the multi-plate coupling in the cover with the inserted coupling hub and side gear, and, finally, the carrier part has to be placed on to said pre-assembled unit in which the other sideshaft gear and the differential gears can be securely held

by the bearing journal for the differential gears. The assembly procedure for the entire differential carrier is thus substantially simplified.

Furthermore, according to a preferred embodiment, it is proposed that on the outside of the cover, there is arranged a sleeve which axially supports an actuator for the locking coupling; the actuator can also be radially supported on the sleeve, provided it is not supported in a contact-free way relative to the sleeve in the differential housing.

For improving the cooling of the multi-plate coupling, it is possible to provide the cover with apertures through which any oil contained in the differential housing can constantly flow towards the coupling plates. Furthermore, the apertures can be associated with blades with a centripetal effect on the oil in the differential housing, which blades, when the differential carrier rotates, scoop up oil from the outside on to the multi-plate coupling. The blades are adapted to the preferred direction of rotation of the differential carrier, which direction corresponds to the forward driving direction of the motor vehicle comprising the differential drive.

A preferred embodiment of the invention is illustrated in the drawings and will be described below.

Figure 1 shows an inventive differential carrier in a 3-D view.

Figure 2 shows a differential carrier according to Figure 1 in a longitudinal section.

Figure 3 shows the cover of the differential carrier according to Figure 2 in a longitudinal section.

Figure 4 shows the cover in a cross-section according to the sectional line in Figure 3.

Figure 1 shows a differential carrier 11 which, substantially, consists of a carrier part 12 with a formed-on flange 13 and of a cover part 14 with a formed-on flange 15. A first bearing sleeve 16 on to which it is possible to slip a rolling contact bearing is formed on to the carrier part 12. A second bearing sleeve 17 on to which it is possible to slip a second rolling contact bearing is formed on to the cover 14. The rolling contact bearings are used to rotatably support the differential carrier in a drive housing (not illustrated). The flanges 13, 15 are shown to comprise through-bores 18 by means of which the parts 12, 14 of the differential carrier can be bolted together, and a ring gear (not shown) for rotatingly driving the differential carrier can be bolted to the flanges. The carrier part is shown to comprise first bores 19 into which there are inserted journals 25 for differential gears, which journals 25 are secured by securing rings 20. Furthermore, there are shown second apertures 21 which allow the supply of oil to the interior of the differential carrier.

The cover part 14 is provided with apertures 22 through which it can be seen that a plate package 23 is arranged inside the cover 14. Scooping wings or blades 24 are associated with the apertures; when the differential carrier rotates, said blades 24 are used to supply oil on to the outside of the plate package 23. An actuator 31 is arranged coaxially relative to the cover 14 and, substantially, comprises a rotatingly drivable setting disc 32 with a tooth segment 33 and an axially displaceable pressure disc 34 which, by a claw 35, is held in a rotationally fast way relative to a journal 36 fixed

in the housing. The setting disc 32 is axially supported against a supporting disc 37 which, by means of a securing ring 38, is fixed to a largely covered sleeve inside the actuator. The actuator 31 is arranged so as to be in a stationary condition relative to the housing (not illustrated), whereas the differential carrier 11 is normally permanently driven so as to rotate.

In Figure 2, any details identical to those shown in Figure 1 have been given the same reference numbers. To that extent, reference is made to the description of same. As far as details are concerned, it can be seen that into the carrier part 12 there have been inserted journals 25 which intersect one another and on which there are supported differential gears 26, 27. The differential gears 26, 27 engage sideshaft gears 28, 29. A first sideshaft gear 28 is slidingly supported in the carrier part 12, whereas a second sideshaft gear 29 is guided substantially self-centringly between the differential gears 26, 27. The latter sideshaft gear 29 is produced so as to be integral with a coupling hub 30 and carries the inner plates of the plate package 23. The outer plates of the plate package 23 are form-fittingly held in the cover 14 which is shown in section in the region of the blades 24 and the apertures 23. Between the cover 14 and the hub 30 a supporting disc can be identified. The actuator 31 is shown to comprise further details in addition to the rotatingly drivable setting disc 32, the pressure disc 34 being held so as to be rotationally fast and the supporting disc 37 being axially secured by the securing ring 38; said further details being an axial bearing 41 between the setting disc 32 and the supporting disc 37, a radial bearing 42 via which the setting disc 32 is supported on a sleeve 51 and balls 43 running in pairs of ball grooves in the discs 32, 34. A plurality of balls 43 is circumferentially distributed in a cage 44 and

held at identical distances. As is known the depth of the ball grooves (not individually identified) in the opposing surfaces of the discs varies around the circumference, so that, when the setting disc 32 is rotated relative to the pressure disc 34, the balls run from the deeper groove regions into the shallower groove regions. Thereby, the pressure disc 34 held so as to be non-rotatable, pushes itself axially away from the setting disc 32. Via a further needle bearing 45 and a first pressure plate 46, the inner pressure disc 48 is pressure-loaded and axially displaced by journals 47 which axially pass through the cover 14. Said inner pressure disc 48 pushes together the plate package 23 which is supported on an annular face 49 of the carrier part 12. When the setting disc 32 is returned, the pressure plate 46 is pushed back via a plate spring 50, so that the load is removed from the plate package 23. By closing the plate package, there is built up a locking moment between the sideshaft gears 28, 29.

Figure 3 shows the cover according to Figure 2 in a slightly modified form as a detail. Any details identical those shown in Figure 2 have been given the same reference numbers. Inside the cover 14, there are circumferentially distributed longitudinal grooves 52 which can be engaged in a form-fitting way by projections provided at the outer plates. Inside the sleeve 17 it is possible to identify a lubricating groove 53. It can be seen more easily that the blades 24 are associated with the apertures 22.

In Figure 4, any details identical to those shown in Figures 2 and 3 have been given the same reference numbers. The cover 14 is provided with longitudinal grooves 52 to allow a form-fitting and positive engagement of the outer plates, and with axial through-holes 54 into which the above-mentioned journals are inserted. It is also possible to see in detail the shape

and functioning of the blades 24 in cooperation with the apertures 22 which assumes a clockwise movement of the cover 14. In addition to the blades, it is possible to see cooling ribs 40 which at the same time reinforce the cover 14.

The cover 14 shown in Figures 3 and 4, together with the plate package shown in Figure 2 and the sideshaft gear 29, can be removed and replaced by a second sideshaft gear symmetrical to the sideshaft gear 28 and by a substantially flat cover in order to obtain - starting from the same dish part 12 - an open differential which is not separate.

GKN Driveline International GmbH  
Hauptstrasse 130  
53797 Lohmar

18<sup>th</sup> December 2003  
Ne/gro (20030596)  
Q03094W000

**Differential carrier with an inner plate package**

List of reference numbers

- 11 multi-plate coupling
- 12 dish part
- 13 flange
- 14 cover part
- 15 flange
- 16 bearing sleeve
- 17 bearing sleeve
- 18 bolt hole
- 19 through-hole
- 20 securing ring
- 21 aperture
- 22 aperture
- 23 plate package
- 24 blade
- 25 journal
- 26 differential gear
- 27 differential gear
- 28 sideshaft gear
- 29 sideshaft gear
- 30 coupling hub
- 31 actuator
- 32 setting disc

33 tooth segment  
34 pressure disc  
35 claw  
36 journal  
37 supporting disc  
38 securing ring  
39 disc  
40 cooling rib  
41 axial bearing  
42 axial bearing  
43 ball  
44 ball cage  
45 axial bearing  
46 pressure disc  
47 journal  
48 pressure disc  
49 supporting face  
50 plate spring  
51 sleeve

GKN Driveline International GmbH  
Hauptstrasse 130  
53797 Lohmar

18<sup>th</sup> December 2003  
Ne/gro (20030596)  
Q03094W000

**Differential carrier with an inner plate package**

**Abstract**

A differential drive with a rotatably arranged differential carrier 11 in which a multi-plate coupling 23 is arranged so as to be effective between the differential carrier 11 and a sideshaft gear 29, wherein the differential carrier 11 comprises a dish-shaped carrier part 12 in which there are received sideshaft gears 28, 29 and differential gears 26, 27. The differential carrier comprises a dish-shaped cover 14 which receives the plates of the multi-plate coupling 23.